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Fuzzy COPRAS-F Method for Selection Budget Hotel in Kuala Perlis

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Abstract
Budget hotel is a low-cost hotel that provides basic facilities for guests and the best hotels for people to stay while travelling. However, there are several criteria (factors) that need to be considered when selecting a budget hotel. The aim of this study is to identify and rank important criteria (factors) for the selection of budget hotels and to determine the best selected budget hotels in Kuala Perlis. The study used a Multi-Criteria Decision Making (MCDM) approach for the methodological perspective. The study adopted the Fuzzy Complex Proportional Assessment (COPRAS-F) method for ranking of five criteria (factors) namely, price, location, cleanliness, service and facilities provided by the budget hotel. The results indicated that the important factors selecting budget hotel has been achieved using Fuzzy COPRAS-F method.
Keywords: Fuzzy Complex Proportional Assessment (COPRAS-F), Multi-Criteria Decision Making (MCDM), Budget Hotel, Cleanliness, Ranking.

Introduction

Budget hotel is categorised as a low-cost hotel chosen by the customer for a reasonable price compared to a luxury hotel and offers basic services to the customer. Budget hotel is a small hotel organised by a person or a small group of people and usually has only one or two floors, with less than 100 rooms. According to Samy (2016), budget hotels are also known as limited-service hotels, no-frill hotels and economy hotels. It is also known as a small, below rated hotel. Since budget hotels also have an important role to play in contributing to the growth of hotel business in Malaysia, it is important to be competitive and successful in this business.

Providing good quality services and keeping customers satisfied is important for the success of the budget hotel (Ahmad et al., 2018). In view of the customer's priorities, budget hotel

managers require a thorough investigation to identify important budget hotel selection factors. Many studies have found that cleanliness, location, room rate, security, service quality, business facilities, room and front desk, food and recreation, security and the reputation of the hotel are often considered by customers in making hotel choice decision (Baniya & Thapa, 2017). However, no study has been conducted on important selection factors for budget hotels.

There are a number of methods discussed for the selection of hotel factors. According to Popovic, Stanujkic, Brzakovic and Karabasevic (2019), a multi-criteria decision-making method of step-wise weight assessment (SWARA) and weighted sum method based on decision maker's preferred level of performances (WS PLP) was used to analyze the choice of strategic location for hotel construction. Other than that, according to Digkoglou, Dragoslis, Papathanasiou, and Kostoglou (2017), the research looked at the ranking of eight hotels in European countries and analyzed several criteria (factors) to be considered, namely hotel location, cleanliness, number of rooms, service provided, customer sleep quality, value, hotel stars, price, and distance from the city centre. The study used the multi-criteria decision-making method of the analytical hierarchy (AHP) process and the VIKOR method.

However, the aim of this study is to apply the Fuzzy COPRAS-F method in order to identify the most important budget hotel selection factors. The reason to use Fuzzy COPRAS-F is because this method can rank both criteria and alternative in the study. According to Bekar, Cakmakci, and Kahraman (2016), this method has several advantages compared to others methods. This method requires only small samples of criteria, alternatives and decision makers. Furthermore, it also can determine the most important criteria using linguistic variable which suitable to use in real life applications. This method also uses simple software with simple calculation to evaluate the results.

Method of Fuzzy Complex Proportional Assessment (COPRAS-F)

COPRAS-F is referred to as the Fuzzy Complex Proportional Assessment. Can and Kilic Delice (2018) have found that COPRAS was developed by Zavadskas and Kaklauskas. This approach is used where the decision-maker must choose the best alternative from a significant number of alternatives by applying a number of parameters known as evaluation criteria (factors) (Ebrahimi et al., 2016). It is used to interpret expert judgments in an accurate ranking based on an integrated approach. In this method, there are several things that need to be considered such as alternatives, criteria (factors) and decision-maker preferences. This method includes a process in determine the weighting of the assessment criteria (factors). The weight of the parameters and the ranking of the alternatives are correctly defined and crisp values can be used in the assessment process. In order to evaluate the outcome of the option, it is important to identify the assessment criteria (factors), analyse the related data on the demand for rating problems, and then proceed with the evaluation model of those criteria (factors) with a view to meeting the needs of the participants (Roy et al., 2019).

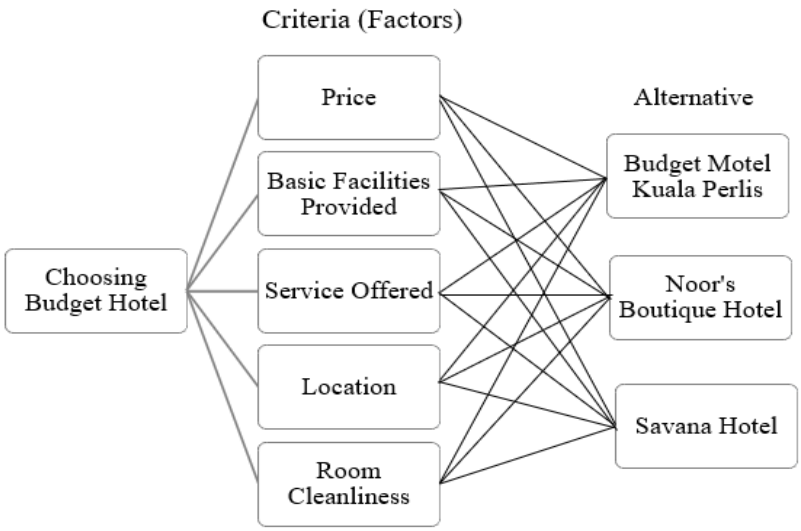

Figure 1. Hierarchical structure of budget hotel selection

There are two objectives in this study: -

To determine and ranking the important criteria (factors) for the selection of the budget hotel

To determine the best budget hotel in Kuala Perlis

Questionnaires were distributed to six expert respondents for the selection of the best criteria (factors) for the selection of budget hotels and analyzed using Microsoft Excel 2016.

Step 1: *The triangular fuzzy number* in Table 1 for criteria (factors) and Table 2 for alternatives were used in describing a fuzzy event is adapted from Yazdani et. al (2011).

Table 1. Fuzzy number and linguistic variable for the importance of criteria (factors)

Linguistic variable	Fuzzy number
Not important (NI)	(0,0,0.25)
Weak important (WI)	(0,0.25,0.5)
Important (I)	(0.25,0.5,0.75)
Strong Important (SI)	(0.5,0.75,1)
Extremely Important (EI)	(0.75,1,1)

Table 2. Fuzzy number and linguistic variables of the alternatives

Linguistic variable	Fuzzy number
Very Poor (VP)	(0, 0, 2.5)
Poor (P)	(0, 2.5, 5)
Fair (F)	(2.5, 5, 7.5)
Good (G)	(5, 7.5, 10)
Very Good (VG)	(7.5, 10, 10)

Step 2: *Converted of linguistic variables into fuzzy number.*
After collecting the result from the decision makers, the linguistic variables were converted into a fuzzy number.

Step 3**:** *Construction of the fuzzy decision matrix*.
Based on the level of satisfaction of the criteria (factors) used by the expert opinion, the researcher has a fuzzy decision matrix. By making reference to equation 1, the attribute used was defined as C_n by reference to the criteria (factors), A_n by reference to the alternative, $\widetilde{D}$ by reference to the fuzzy decision matrix, and $\tilde{X}_{mn}$ by reference to the alternative value based on the criteria (factors) according to which *m* is the alternative and *n* is the criterion.

$$D=\begin{matrix} C_1 & C_2 & \dots & C_n \end{matrix}\begin{bmatrix} [X_{11}] & [X_{12}] & \dots & [X_{1n}] \\ [X_{21}] & [X_{22}] & \dots & [X_{2n}] \\ \vdots & \vdots & \ddots & \vdots \\ [X_{m1}] & [X_{m2}] & \dots & [X_{mn}] \end{bmatrix}\begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \quad (1)$$

Then, the final weight of the criteria (factors), $\widetilde{W}$ was formed as below:

$$W=(w_1, w_2, \dots, w_n) \quad (2)$$

Step 4: *The average for the fuzzy number of six experts for each of the criteria (factors) was calculated*.

Step 5: The Centre of Area (COA) method, or the Centroid method then used to *determine the defuzzification of the fuzzy decision matrix and the fuzzy weight of each criterion*. The attribute $L\widetilde{R}_i$ was lower fuzzy number, $M\widetilde{R}_i$ was medium fuzzy number and $U\widetilde{R}_i$ was upper fuzzy number and $\widetilde{R}_i$represented as a triangular fuzzy number.

$$R_i=(LR_i, MR_i, UR_i)$$

The defuzzification value, $BN\widetilde{P}_i$ was calculated by using equation 3 for criteria (factors) and alternatives. The value obtained was converted into a crisp form.

$$BNP_i=\frac{(UR_i-LR_i)+(MR_i-LR_i)}{3}+LR_i \quad (3)$$

Step 6: *The normalized defuzzified of the criteria (factors) for each alternative was calculated* using equation 4 as indicated below.

$$\bar{X}_{ij}=\frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad (4)$$

where,

$$i=1,2,\dots,m, j=1,2,\dots,n$$

The value obtained was then formed in the normalized decision matrix, $\bar{X}$.

$$X = \begin{bmatrix} [X_{11}] & [X_{12}] & \cdots & [X_{1n}] \\ [X_{21}] & [X_{22}] & \cdots & [X_{2n}] \\ \vdots & \vdots & \ddots & \vdots \\ [X_{m1}] & [X_{m2}] & \cdots & [X_{mn}] \end{bmatrix} \quad (5)$$

Step 7: The weight of normalization decision matrix, $\hat{X}_{ij}$ was calculated by using the value from the normalized decision matrix and the crisp value.

$$\hat{X}_{ij} = X_{ij} W_j, i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n \quad (6)$$

W_j is the weight or the crisp value of the j^{th} attributes.

Step 8: *Calculated the sum of* P_i *and the sum of* R_i.

The calculation for the benefit criteria (factors), P_i is shown in equation 7. Higher values are preferable.

$$P_i = \sum_{j=1}^{K} \hat{X}_{ij} \quad (7)$$

Equation 8 shows the calculation of the cost criteria (factors), R_i. Lower values are more preferable.

$$R_i = \sum_{j=K+1}^{n} \hat{X}_{ij} \quad (8)$$

where *K* was the number of criteria (factors).

Step 9: *Calculated the minimum amount of cost criteria (factors),* R_i.

$$R_i = min_i \cdot R_i; = 1,2, \ldots, m \quad (9)$$

Step 10: *The relative significance,* Q_i, then calculated by using Eq. 10 below:

$$Q_i = P_i + \frac{\sum_{i=1}^{m} R_i}{R \sum_{i=1}^{m} \frac{1}{R_i}} \quad (10)$$

Step 11: *The criterion for optimality,* Q_{max} was then determined using the following equation.

$$Q_{max} = \max_i Q, \ i = 1,2,\ldots,m \quad (11)$$

Step 12: *The utility degree,* N_i *of each alternative was calculated* by using the results of relative significant and the maximum value of relative significant, Q_i obtained from the previous step. Then, the equation of utility degree is given below:

$$N_i = \frac{Q}{Q_{max}} \times 100\% \quad (12)$$

Step 13: *The alternatives were ranked on the basis of the value of the degree of utility,* N_i obtained in step 12. The highest value of N_i is the most preferred budget hotel selection.

Result and Discussion

Rank the Important Criteria (Factors) for Selecting the Budget Hotel

Table 3 represents the average of the criteria (factors) and the crisp value using the Fuzzy COPRAS-F method. From the crisp value shown in Table 3, "Cleanliness" is the most important criterion (factors) in the selection of budget hotels, since it had the highest crisp value of 0.79. Other than that, the results show that "Service offered" was less important in the selection of budget hotels because it had the lowest crisp value among the other criteria (factors).

Table 3. The criteria (factors), the average of each criteria (factors), the crisp value and the rank of the criteria (factors)

Criteria (Factors)	Average of criteria (Factors)	Crisp Value	Rank
Price (C1)	(0.33,058,0.83)	0.58	4
Location (C2)	(0.42,0.67,0.92)	0.67	2
Service offered (C3)	(0.38,0.58,0.75)	0.57	5
Cleanliness (C4)	**(0.58,0.83,0.96)**	**0.79**	**1**
Facilities (C5)	(0.38,0.63,0.83)	0.61	3

Determine the Important Criteria (Factors) for Selecting Budget Hotel

When the linguistic variables were converted into a fuzzy number, the average of the alternatives was determined. The average alternative was calculated for each criterion as shown in Table 4. It was calculated from the fuzzy set of six decision makers, based on each alternative and on each criterion. The defuzzification method was used on average and the results were converted into a crisp value as shown in Table 4 below.

Table 4. The crisp value of the alternative based on the criteria (factors)

Alternative	Budget Motel Kuala Perlis (A1)	Noor Boutique Hotel (A2)	CSH Motel (A3)
Price (C1)	**8.33**	**8.06**	**7.78**
Location (C2)	**8.33**	7.50	7.50
Service Offered (C3)	7.36	**8.06**	7.64
Cleanliness (C4)	6.25	6.67	6.11
Facilities (C5)	6.67	6.94	6.94

On the basis of Table 4, the important criteria (factors) for each alternative were determined by the selection of the highest crisp value. In the case of Budget Motel Kuala Perlis, there were two criteria (factors) that were important, namely "Price" and "Location" with a crisp value of 8.33. Then, for Noor Boutique Hotel, "Price" and "Service Offered" had the highest crisp value of 8.06 which were also among the important criteria (factors) in the selection of the budget hotel. Finally, for CSH Motel, the highest value was "Price" with a crisp value of 7.78, as the important criteria (factors) to be considered. Based on the result, the first objective was achieved as the crisp value was used to rank and determine important criteria (factors) for the selection of budget hotels.

Determine the Best of Selected Budget hotel in Kuala Perlis

The value of P_i was therefore the sum of the benefit criteria (factors) and higher values are preferable. The value of R_i was the sum of the cost criteria (factors) and the lower value is more acceptable. The sum of the benefits criteria (factors) and the sum of the cost criteria (factors) were calculated and shown in column two of Table 5. Relatively significant, the Q_i was then determined and the degree of utility, N_i was calculated. The result is shown in Table 5.

Alternatives were ranked by the value of the degree of utility N_i . On the basis of Table 5, the last column shows the rank of alternatives. The highest value of the degree of utility, N_i , was 100%, namely Noor Boutique Hotel. Therefore, it was the best budget hotel in Kuala Perlis. The lower rated budget hotel was CSH Motel with a utility degree, N_i with a rate of 96.33%. CSH Motel was therefore the last preferred budget hotel among selected of budget hotel to be chosen in Kuala Perlis.

Table 5. The result of ranking the alternative by using fuzzy COPRAS-F

Alternative	Sum of benefits criteria (factors), P_i	Sum of cost criteria (factors), R_i	Relative significant, Q_i	Utility degree, N_i (%)	Rank
Budget Motel Kuala Perlis (A1)	0.88	0.20	1.08	98.88%	2
Noor Boutique Hotel (A2)	**0.90**	**0.19**	**1.09**	**100%**	**1**
CSH Motel (A3)	0.86	0.19	1.05	96.33%	3

Conclusion and Recommendation

Based on the result, both the ranking objectives and the determination of the important criteria (factors) and the determination of the best selected among budget hotels had been achieved by the use of the crisp value and the degree of utility. Cleanliness with a crisp value of 0.79 was the first rank for the important criteria (factors). The important criteria (factors) for each alternative were then determined. For Budget Motel Kuala Perlis, the main criteria (factors) were price and location with a crisp value of 8.33. For Noor Boutique Hotel, the important criteria (factors) were the price and service offered at a crisp value of 8.06. Lastly, the most important criteria (factors) for the CSH Motel were price with a crisp value of 7.78. Then, for the second objective, Noor Boutique Hotel with a utility degree of 100% was the best selection among budget hotels in Kuala Perlis. Based on the result, it is shown that the Fuzzy COPRAS-F method helps to identify and rank important criteria (factors) and to identify the best alternatives among selected budget hotels in Kuala Perlis.

In future research, this study suggests the addition of additional criteria (factors) and sub-criteria (sub-factors) to be assessed. Examples of criteria (factors) that can be added are security, room type and reputation of a budget hotel and examples of sub-criteria (sub-factors) that can be added are the type of room: either a standard room, a family room or a double family room. Adding more criteria (factors) and sub-criteria (sub-factors) provides decision makers with relevant facts, insights and expertise.

Other than that, the researcher may use a different method in multi-criteria decision making to determine the best selected budget hotel and rank the most important of the criteria (factors). For example, the other methods that can be used for this study are Fuzzy Analytic Hierarchy (AHP) and Fuzzy PROMETHEE (Preference Ranking Organisation Method for Enrichment and Evaluation). However, with small alterations, different methods will produce different solutions and results.

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